TYPE 1500B
WOBBULATOR

INSTRUCTION BOOK

Tel-Instrument
ELECTRONICS CORP.

728 GARDEN STREET
CARLSTADT, NEW JERSEY 07072

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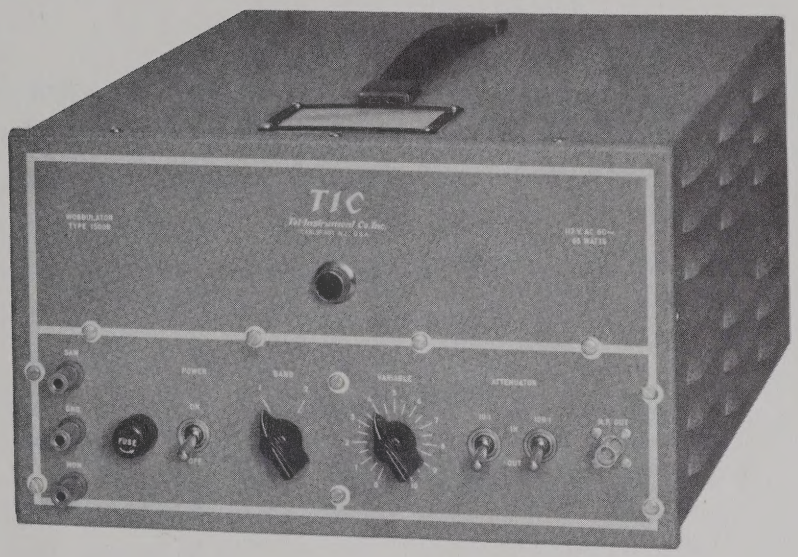
WOBBULATOR



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INTRODUCTION

The Type 1500B Wobbulator is a two band instrument specifically designed for the alignment of broad band IF's in television, radar, and FM receivers. Each instrument is adjusted at the factory to the center frequency and bandwith required by the customer for each band and up to five crystal controlled pulse-type markers can be provided per band. The RF output voltage is adjustable from below 100 microvolts to a maximum of 1 volt, and appears at the end of a four foot terminated 75 ohm coaxial cable. The return trace is blanked out to prevent confusion and to provide a convenient baseline for amplitude measurements. A synchronized saw-tooth sweep is provided for the associated oscilloscope. In addition, a monitor crystal is connected across the RF output jack for checking purposes and to enable checking terminations of long coaxial cables.

The entire unit is contained in an attractive gray wrinkle enamel finished steel cabinet 7 inches high, by 12 inches wide, by 14 inches deep, with a panel finished in gray wrinkle enamel and white letters. A celluloid-protected chart on top of the cabinet gives the serial number, band limits, and marker frequencies for the unit, and a leather-covered handle enables the unit to be readily carried around. The instrument operates from a 117 volt 50/60 cycle power line from which it draws only 65 watts.

OPERATING PRECAUTIONS
WARNING

Before attempting to use this instrument please follow this procedure:

Plug the line cord plug into a source of 117 VAC, and actuate the power switch to the "ON" position. Now connect the "Y" axis amplifier of a DuMont Type 208 scope or its equivalent to the "MON" output and ground binding posts and connect a 100 MMF mica capacitor across the Y axis terminals to bypass any residual RF that might be on the lead. Connect the "SAW" output binding post to the "X" axis input of the scope and turn "OFF", the scope sweep. Connect the Type 1630 output cable to the UG290/u connector on the front panel. Observe that a sweep signal is produced by the type 1500B and check this by removing the lead to the "X" axis input post. If the signal disappears then you have set it up correctly, if it does not disappear you have not turned the sweep range switch on the scope to the "OFF" position. Now that the sweep signal is operating correctly adjust the "Y" axis gain until you obtain two horizontal traces and adjust them so that they are about 1½ inches apart. Now observe the top trace and you will note several slight notches and a faint trace extending down to, or almost down to, the bottom or base line at each notch, these are the markers. Now switch the band selector to the other band and you will note a set of markers located slightly differently. There may be from one to five markers on each band as indicated on the chart located on the top of the unit. Now that you have ascertained that the markers are all there, and the unit operates properly, you may use it to adjust IF amplifiers. If you do not find the markers when using this instrument as outlined in the following paragraphs it is because the pass band of the receiver is incorrectly adjusted and there is no output at that frequency. Unless there is some output you will not see a marker.

Proper use of the Type 1500B Wobbulator is quite simple, as all bandwidth and center frequency adjustments are internally made at the factory at the time of manufacture. To place the instrument into service, plug the power cord into a source at 117 V 60 cycle single phase AC, operate the power switch to "ON", connect the sweep output and ground posts to the associated CRO, and then connect the RF output cable to the IF system to be tested. Only two accessories are required; a crystal or vacuum tube detector probe, and a cathode-ray oscilloscope having a very good sixty-cycle *square wave* response (such as the DuMont Type 208). In some cases, it may be possible to use the detector already present in the receiver, but this will depend on the circuits in question and whether stage-by-stage or overall alignment is being attempted. In many instances the use of a detector of known characteristics may be advantageous. The RF output probe, Type 1630, furnished with the 1500B incorporates a blocking capacitor so that connection may be made to the plate or grid of a tube without fear of disturbing DC voltage relationships. The low impedance of the probe will considerably broaden any circuit across which it may be connected so there should always be a buffer tube between the probe and the circuit being adjusted.

At the frequencies at which the 1500B operates, the question of ground lead inductance is very important, and it will be found that much more consistent results will be obtained if a large, suitably grounded, sheet of copper is placed on the workbench. The 1500B, the receiver of IF strip being aligned, and the oscilloscope should be placed on the sheet, and connected to it with short, heavy, ground leads. Soft copper strips .015 thick and ½ inch wide are recommended. Copper braid is not recommended. Both the RF output probe and the detector probe should be connected into the circuit using leads as short as possible, certainly not longer than 2 inches. In order to help eliminate RF pickup on the detector cable, it will often be found helpful to place a small capacitor up to 270 MMF across the detector cable right at the oscilloscope terminals. Do not use large values of capacitance as the resultant decrease in high frequency response of the detector probe will decrease the marker amplitude.

It is *extremely* important, when attempting to align broad band IF's, to follow the procedure suggested by the manufacturer of the equipment, as otherwise mediocre or poor operation will result. Certain unique features of the 1500B, however, will eliminate the need for some of the equipment usually required. For example, an auxiliary CW signal generator, usually required for producing "Birdie" markers will not be required as the 1500B has up to five built-in crystal controlled pulse-type markers per band. By the same token, the precision heterodyne-type frequency meter recommended for calibrating the CW generator may be dispensed with. As the saw-tooth sweep voltage from the 1500B is automatically synchronized, no external phase-shift network is needed between the 1500B and "X" axis input of the oscilloscope.

One precaution that must always be kept in mind, and checked for each new setup, is the matter of detector linearity. It will be found that under many test conditions the voltage being fed to the detector or detector probe is insufficient to guarantee operation in the linear region. If this is so, the 50% point on a response curve, for example, will NOT appear halfway between the flat-top portion of the curve and the base line provided by the 1500B. If the detector has been calibrated for linearity of input versus output, this may be taken into account and compensated for.

THEORY OF OPERATION

The Type 1500B Wobbulator consists of the following major functional subdivisions:

a. Oscillator
b. Marker Generator
c. Keying and Sweep Generator
d. Power Supply
e. Attenuator System
f. Monitoring System

A. Oscillator

The RF oscillator consists essentially of V7, capacitor Type 1800, an either coil L1 or L2 as selected by the front panel "Band" control to form a push-pull oscillator. Capacitors C20 to C25, whose values are adjusted at the factory at the time of manufacture, determine over what percentage bandwidth the vibrating capacitor unit Type 1800B will swing the oscillator. This method of bandwidth control is used rather than control of the driving voltage to the voice coil of the unit for two reasons. One is that at very low drives, such as might be encountered in a narrow-band sound IF sweep, a slight microphonic tendency sometimes becomes noticeable. The other is that if the driving voltage is varied, the phase relationship between the movement of the voice coil and the driving voltage will be varied which would necessitate readjustment of certain phase-shifting networks to be described later. A 3TK2 current regulator tube keeps the driver voice coil voltage constant even though the line voltage changes from 105 to 125 volts. Due to the thermal lag of this tube, the voice coil voltage will be excessive for a few seconds after the unit is turned on, and the capacitor plates may hit. This is not abnormal, as the voltage will decrease as the 3TK2 warms up.

At full driving voltage, which is about 3.5 volts, the Type 1800B vibrating capacitor is capable of producing approximately a ± 18% frequency swing, under the conditions of stray circuit capacitance prevailing in the Type 1500B Wobbulator. It should be noted that the frequency sweep is NOT absolutely linear in frequency with respect to either the vibrating capacitor driving voltage or the sweep voltage furnished by the unit. This is not a disadvantage as crystal controlled markers appear at all the important frequencies. It will be noticed that variable capacitors are provided for adjusting the drive to each grid of the oscillator and also for balancing the oscillator with respect to ground. It has been found that these provisions are essential to obtain a flat output over the wider bandwidths employed in this instrument. The procedure for readjusting these capacitors is discussed in the "MAINTENANCE" section of this instruction book. The oscillator is keyed "ON" by a square wave voltage injected in the grid circuit, during the interval when the vibrating capacitor is causing its frequency to increase and keyed "OFF" while its frequency would be decreasing, thus preventing the operator from being confused by the back trace. The RF output of the oscillator is fed through a link to the attenuator and crystal marker circuits.

B. Marker Generator

As the oscillator frequency sweeps through the resonant frequency of the crystal, it shock-excites the crystal, causing it to generate a chain of damped oscillations. As the bandwith through which the oscillator is swept is reduced, the crystal becomes over-excited, as it takes longer for the oscillator to sweep through the resonance curve of the crystal and thus the energy-time integral has a higher value. To correct this, damping resistors are placed across those crystals which are to be used to produce markers on low-sweep deviation bands. For our purposes it is necessary to select the first ring of these crystals, shape it into a pulse of the desired width, and then use this pulse to key the oscillator to zero output for a time corresponding to the width of the pulse. This is accomplished, in its preliminary form, by five separate sets of diodes and triodes, with an auxiliary pulse-shaping network between them. The five signals (or less, if fewer than five markers per band are ordered) are then all fed to one section of V10 which feeds the signal to C10 and R21 on a short-time constant charge, long-time constant discharge basis and then to the other half of V10 which has an adjustable bias applied to it to prevent certain low amplitude signals which are present at the same time from feeding through.

The diode section V14B is connected in parallel with the second half of V10 to prevent pulse overshoot on the rear half of the pulse and is provided with adjustable bias to control the voltage at which diode current flows.

It has been found by experience that there is a limit as regards the closeness of marker frequencies under certain conditions. In the case of a 20 to 30 MC sweep it has been found impractical to space markers closer than 500 KC. Since such close spacing of markers is never required for the alignment of television receiver Video IF amplifiers, this limitation is of no consequence. In the case of the Sound IF alignment, markers are usually spaced either 50 KC or 100 KC apart but the total bandwidth is usually only 250 to 500 KC and for these bandwidths the 50 or 100 KC spacing is entirely satisfactory.

C. Keying and Sweep Generator

The AC voltage from the high voltage winding of the power transformer is applied to the 90° phase shift network composed of R80, R81, C4 and C5. The output of this network is fed to a second network R8, C47 which has a range of about 150°. Adjustment of R8 allows the negative half cycle of the voltage applied to V5 to occur during the time the capacitance of the Type 1800B is decreasing. This voltage, after being limited in maximum value by neon bulb V5, is applied to the grid of V13B, where it is limited to produce a square wave of voltage at the plate. This voltage, along with the pulse marker voltage, is fed to the RF oscillator where it produces the gating action described before. The AC voltage across V5 is also coupled to one section of V6 producing at the plate of the tube a square wave of the same phase as at the plate of V13B. This square wave voltage is fed through integrating network R10, C6, producing a triangular shaped wave which is fed to the other half of V6, acting as a cathode follower. Thus the output of this tube provides a sweep voltage for the associated cathode ray oscilloscope which is always in phase with the gating voltage and in phase with the frequency sweep when phase-shifting network has been adjusted.

D. Power Supply

The power supply section of the instrument consists of a standard full-wave rectifier, with a single section capacitor filter feeding a standard degenerative voltage regulator circuit to maintain a supply potential of 250 volts for the rest of the instrument under all variations in line potential.

E. Attenuator System

The RF output of the oscillator is fed through series resistors R33 and R34 to a low impedance potentiometer R38. The maximum voltage across this potentiometer is set at the factory to 1 volt and is adjustable over a range of 10:1. This voltage is fed through two toggle-switch type attenuator sections, one having an attentuation of 10:1, the other an attentuation of 100:1, and thence to a miniature coaxial jack on the panel. This jack normally feeds a terminated 75 ohm cable and it will be noticed that the two attenuators are designed to show and impedance of 75 ohms when feeding a 75 ohm load so that the impedance into which the potentiometer feeds its voltage is constant at all times. It should be noted that the attenuator is not a precision device, as only 5% resistors are used, and that the linear panel scale provided for R38 does NOT give readings exactly proportional to output voltage.

F. Monitoring Signal

The RF output voltage at the panel coax jack is also fed to a 1N34 crystal detector and the rectified voltage after being filtered, is fed to a binding post on the panel marked "MON".

MAINTENANCE

A. General

Most of the troubles that will occur with this instrument, as in any other electronic instrument, will be found to be due to failure of vacuum tubes. All of the tubes used are standard commercial types and no trouble should be had in obtaining replacements. It should be noted that the 991 is identical with the NE-16 but is NOT the same as the NE-48. The 991/NE-16 is especially adapted to voltage regulator work, while the NE-48 is a standard neon lamp for illumination work. Also the NE-51 NEON lamp should not be replaced with a #51 incandescent lamp. The pilot light is a standard #47 pilot bulb, rated at 6-8 volts, 150 ma, and may be replaced from the front of the instrument by unscrewing the pilot jewel. If it is necessary to remove the instrument from its case, this is done by removing the three #10 screws on the back of the case, and withdrawing the unit from the case. *DO NOT* remove any screws from the front panel as these are used ONLY to fasten the attenuator shield and chassis to the front panel.

B. Marker Adjustment

The performance of the marker circuit is controlled by the setting of R18 (or R19, depending on the band in use) and R16. The settings of these two controls is somewhat interdependent, and it may be necessary to make several trials to obtain optimum settings. R16 should be kept as far counter-clockwise as will give the desired results, as, if it is turned too far clockwise, it will affect the output of the RF oscillator. If the deviation of the oscillator is changed considerably from the factory setting, it may be necessary to change the damping resistors across the crystals; the lower the deviation the lower the resistor value. If a change in marker crystals, or a major change in frequency or bandwidth is required, it is suggested that the instrument be returned to the factory as the adjustment is done free of charge when new crystals are purchased. This procedure also guarantees the most satisfactory results.

If it is desired to replace crystals the following hints might prove helpful. Let us assume that the instrument is operating properly and it is desired to change one or more marker crystals. Set up the 1500B with a 208 Scope as outlined at the beginning of paragraph entitled "Operating Precautions" in this manual. Observe the presence of the markers and then rotate either R18 or R19 depending on the band in use till the markers just begin to move up from the zero signal reference base line. Assuming R18 was adjusted, then a slight additional adjustment will cause the markers to rise to the upper trace and if carried further the markers will disappear. It will be noted that some of the markers will hang onto the baseline longer than the others. If the series resistors such as R48, R49, R50, R51, etc., for each crystal are properly adjusted all the markers will leave the baseline at the same setting of R18. If they do not, then adjustment of the series resistors will make the performance uniform. It is important that ALL the markers leave the baseline together and additional care spent on the adjustment of the series resistors will be repaid by the most stable marker performance. If crystals are replaced the same procedure and adjustments should be made. A little cut and try will quickly familiarize one with the technique and the manner of adjustment. Usually the series resistors have values of around 1200 ohms. For narrow band sweeps such as ± 250 KC the use of shunt resistors across each crystal such as R47 for Y10 are required to prevent secondary markers from appearing to the right of the proper marker. Always carefully check the marker accuracy using a precision signal generator and the "Birdie" method. Occasionally, if the shunting resistor is too low in value, the freqency of the marker will be outside of proper limits. As a general rule, approximately the same value of shunting or series resistors are required. This may be helpful as a starting point when substituting a new crystal. Usually, crystals of the same general frequency such as would be used together on a given band will have approximately the same electrical characteristics and require about the same values of shunting or series resistors.

Crystals for the Type 1500 were soldered into place and were not readily removable without opening the bottom of the unit and unsoldering leads. The Type 1500B has plug-in type crystals that may be removed from the top and easily changed. Both types of crystals are identical electrically and differ only as to the holder. In an emergency they may be used interchangeably with a little ingenuity.

C. Band Frequency Centering

Minor adjustments of the center frequency of either band of the oscillator may be accomplished by adjustment of the iron-dust slugs in the coils, these adjustments may be made from the top of the chassis. The sweep limits of the oscillator may best be found by mixing the RF output from the unit with a CW signal from an accurately calibrated oscillator, and feeding the combination into a crystal detector and cathode ray oscilloscope. It will be noted that a zero beat voltage or birdie is produced as the wobbulator frequency crosses the frequency of the CW generator. This method may also be used to check the frequency of the crystal markers, but a secondary standard of some type will have to be used as very few signal generators of themselves have the required accuracy.

If a major readjustment of the RF oscillator is required, and it is not desired to send the instrument back to the factory for one reason or another, the following notes will be of assistance.

D. Output Flatness Adjustment

The most important adjustments for flatness are the cross coupling capacitors and the position of the pickup link. The position of the iron core will affect the percent coupling, so adjustment of the core should be followed by readjustment of the link. The link is normally correctly positioned when the maximum RF output is 1 volt, as measured on a Measurements Model 62 VTVM or similar RF VTVM at the end of the terminated 75 ohm cable. The balancing capacitors will often help eliminate odd bumps in the output that no adjustment of the cross coupling condensers will eliminate. The padding condensers C21 and C25 control the bandwidth of narrow band sweeps only as they are not provided for wide band sweeps. The bandwidth of the wide band sweep is adjusted by means of R27, but this should never be set for more than 3.5 volts, or the point where the plates in the vibrating capacitor hit, whichever comes first.

E. Adjustment of Type 1800B Wobbulator Capacitor

If trouble is encountered with the Type 1800B variable capacitor, it will probably appear as an audible scraping sound and visually as an erratic output on the cathode ray oscilloscope. This usually indicates that the unit has come out of line mechanically, and it may be possible for the user to readjust it himself. The first thing to do is to set up the unit so that a normal trace is observed on the scope, then open the bottom and leave the unit on its back so that the three elastic stop nuts on the stator support ring of the Type 1800B capacitor are facing upwards and accessible. Using a $\frac{3}{8}$" hex socket wrench, turn each nut first $\frac{1}{2}$ turn clockwise, then $\frac{1}{2}$ turn counter-clockwise. If the scraping ceases during this operation leave the nut at the best position and try each of the others in a similar manner. Usually it will be found that one nut gives the best adjustment and cures the trouble. When a clean and continuous upper trace is visible on the scope, then the unit is properly adjusted. In extreme cases it may be necessary to adjust the stator bar slightly.

The FIRST thing to do is to remove the 6X4 rectifier tube, as normally the full B+ voltage appears on the plates of the vibrating capacitor. Then, loosen the two screws holding the crosspiece to the circular piece of material, and move it around slightly. If this does not eliminate the scraping, try loosening the four screws on the crosspiece and moving the two D-shaped stator pieces in relation to each other and the crosspiece. Failure of these attempts indicates either a major realignment is needed or magnetic scraps have gotten into the airgap. In either case the instrument should be returned to the factory for repair, where full facilities for this work are maintained.

F. Replacement of Type 1800 Capacitor

When replacing the Type 1800 capacitor in the older Type 1500 it will be noticed that the replacement unit differs physically from the old unit. The new 1800B unit is directly interchangeable but requires the replacement of R79 by an 18 ohm 1 watt resistor and the removal of R77. At the same time it will be advisable to replace the phasing network with that shown on schematic drawing 1500-50-1, Iss. 8. This network consists of C4, C5, C47, R7, R80, R81. All the Type 1500A and B units have this new phasing network but a few use the old 1800A capacitor and have R79 as 47 ohms and R27 as 100 ohm ½ watt resistors. If R79 is not changed to 18 ohms, insufficient drive will be applied to the 1800B capacitor resulting in insufficient bandwidth. Also note whether the serial number on the label has the letter "R" or "L" suffixed. If an "R" unit is used to replace an "R" unit then no change of wiring to the voice coil terminals will be required, however, if an "L" unit is used to replace an "R" then the leads to the voice coil terminals will have to be reversed. The reason for this is that the voice coil E.M.F. is obtained from the 60 cps supply and the sweep phasing circuit voltage is also obtained from that source. The direction of motion of the capacitor must always be in a certain direction for a given polarity of E.M.F. for the proper presentation and operation of markers. The direction is correct when the capacitor creates a frequency change in the increasing frequency direction during the "ON" cycle. If the leads to the voice coil terminals are reversed, then the direction of motion will be 180° out of phase. The symbol "R" and "L" indicates a "right" or "left" hand unit and is determined by tests at the factory. The only difference between units is that in assembly the leads from the voice coil had been reversed.

G. Sweep Phasing Adjustment

After adjustment of R27, or the vibrating capacitor it may be necessary to readjust phasing control R8. This is done by using the CW generator, as described before, and adjusting R8 until the highest and lowest zero beats come at the extreme right and left ends of the trace. This adjustment will also be required if the instrument is to be used on 50 cycle power instead of the 60 cycle power for which it is normally aligned. All Type 1500A and B units use an improved wide band phasing network. If trouble is encountered with insufficient phasing range, especially after replacement of the 1800 driver, it is recommended that the new phasing circuit be installed.

RETURN OF INSTRUMENT FOR REPAIR

Before returning an instrument to the factory for repair, write, giving serial and Type number and a description of the trouble encountered. Often we can advise you how to remedy the trouble without shipping the instrument to us.

When it is necessary to return an instrument for any reason, it must be properly packed and shipped prepaid. It is also necessary to send a written authorization or a purchase order to cover necessary repairs.

REPLACEABLE PARTS LIST

R1	270K	±20%	½w	composition resistor
R2	100K	±10%	2w	potentiometer, AB* JU1011 SD3048 opt. 4
R3	47K	±20%	½w	composition resistor
R4	470K	±20%	½w	composition resistor
R5	27K	±20%	½w	composition resistor
R6	47K	±20%	½w	composition resistor
R7	1M	±20%	½w	composition resistor
R8	1M	±20%	2w	potentiometer, AB* JU1052 SD3048 opt. 4
R9	1M	±20%	½w	composition resistor
R10	470K	±20%	½w	composition resistor
R11	2.7M	±20%	½w	composition resistor
R12	100K	±20%	½w	composition resistor
R13	2.7M	±20%	½w	composition resistor
R14	270K	±20%	½w	composition resistor
R15	100K	±20%	½w	composition resistor
R16	100K	±10%	2w	potentiometer, AB* JU1041 SD3048 opt. 4
R17	47K	±20%	½w	composition resistor
R18	10K	±10%	2w	potentiometer, AB* JU1031 SD3048 opt. 4
R19	10K	±10%	2w	potentiometer, AB* JU1031 SD3048 opt. 4
R20	150K	±20%	½w	composition resistor
R21	10K	±20%	½w	composition resistor
R22	22K	±20%	½w	composition resistor
R23	270K	±20%	½w	composition resistor
R24	100K	±20%	½w	composition resistor
R25	100K	±20%	½w	composition resistor
R26	470 ohm	±20%	½w	composition resistor
R27	100 ohm	—	2w	wirewound potentiometer, IRC Type W-100
R28	270K	±20%	½w	composition resistor
R29	270K	±20%	½w	composition resistor
R30	270K	±20%	½w	composition resistor
R31	270K	±20%	½w	composition resistor
R32	270K	±20%	½w	composition resistor
R33	220 ohm	±20%	½w	composition resistor
R34	220 ohm	±20%	½w	composition resistor
R35	91 ohm	± 5%	½w	composition resistor
R36	91 ohm	± 5%	½w	composition resistor
R37	360 ohm	± 5%	½w	composition resistor
R38	100 ohm	±10%	2w	potentiometer, AB* JU1011 SD3048 opt. 4
R39	3.6K	± 5%	½w	composition resistor
R40	75 ohm	± 5%	½w	composition resistor
R41	75 ohm	± 5%	½w	composition resistor
R42	10K	±20%	½w	composition resistor
R43	10K	±20%	½w	composition resistor
R44	1M	±20%	½w	composition resistor
R45	47K	±20%	½w	composition resistor
R46	6.8K	±20%	½w	composition resistor
R47	Factory adjusted			composition resistor
R48	Factory adjusted			composition resistor
R49	Factory adjusted			composition resistor
R50	Factory adjusted			composition resistor
R51	Factory adjusted			composition resistor
R52	Factory adjusted			composition resistor
R53	6.8K	±20%	½w	composition resistor
R54	47K	±20%	½w	composition resistor
R55	1M	±20%	½w	composition resistor
R56	1M	±20%	½w	composition resistor
R57	47K	±20%	½w	composition resistor
R58	6.8K	±20%	½w	composition resistor
R59	Factory adjusted			composition resistor
R60	Factory adjusted			composition resistor
R61	Factory adjusted			composition resistor
R62	Factory adjusted			composition resistor
R63	Factory adjusted			composition resistor
R64	Factory adjusted			composition resistor
R65	6.8K	±20%	½w	composition resistor
R66	47K	±20%	½w	composition resistor
R67	1M	±20%	½w	composition resistor
R68	1M	±20%	½w	composition resistor
R69	47K	±20%	½w	composition resistor
R70	6.8K	±20%	½w	composition resistor
R71	Factory adjusted			composition resistor
R72	Factory adjusted			composition resistor
R73	Factory adjusted			composition resistor
R74	470 ohm	±20%	½w	composition resistor
R75	4.7 ohm	±20%	1w	composition resistor
R76	Not assigned			
R77	Not assigned			
R78	270K	±20%	½w	composition resistor
R79	22 ohm	±20%	1w	composition resistor
R80	25K	±20%	20w	wirewound Greenohm resistor
R81	25K	±20%	20w	wirewound Greenohm resistor

*Allen-Bradley

C1	15/15/20 µf., 350/25 v electrolytic condenser
C2	.1 µf., 400 v tubular, Astron MLL-4-1 condenser
C3	4 µf., 600 v oil-filled, TLA-6040 (CD) condenser
C4	.1 µf., 1000 v bathtub, CD-DYR10010G condenser
C5	.1 µf., 1000 v bathtub, CD-DYR10010G condenser
C6	.01 µf., 600 v tubular, one sided grounded condenser
C7	.1 µf., 400 v tubular, Astron MLL-4-1 condenser
C8	15/15/20 µf., 350/25 v electrolytic condenser
C9	470 µµf., mica, RCM20B471K condenser
C10	470 µµf., mica, RCM20B471K condenser
C11	15/15/20 µf., 350/25 v electrolytic condenser
C12	5 µµf., mica, RCM15B050K condenser
C13	1-8 µµf., trimmer, Erie Type 532 condenser
C14	1.5-7 µµf., trimmer NPO, Erie Type TS-2A condenser
C15	1.5-7 µµf., trimmer NPO, Erie Type TS-2A condenser
C16	1-8 µµf., trimmer, Erie Type 532 condenser
C17	1.5-7 µµf., trimmer NPO, Erie Type TS-2A condenser
C18	.25 µf., 400 v tubular, Astron MLL-4-25 condenser
C19	1.5-7 µµf., trimmer NPO, Erie Type TS-2A condenser
C20	Determined at factory, mica RCM20B condenser
C21	Determined at factory, mica RCM20B condenser
C22	Determined at factory, mica RCM20B condenser
C23	Determined at factory, mica RCM20B condenser
C24	Determined at factory, mica RCM20B condenser
C25	Determined at factory, mica RCM20B condenser
C26	1000 µµf., mica RCM20B102K condenser
C27	1000 µµf., mica RCM20B102K condenser
C28	1000 µµf., mica RCM20B102K condenser
C29	1000 µµf., mica RCM20B102K condenser
C30	1000 µµf., mica RCM20B102K condenser
C31	270 µµf., mica RCM20B271K condenser
C32	270 µµf., mica RCM20B271K condenser
C33	1000 µµf., mica RCM20B102K condenser
C34	470 µµf., mica RCM20B471K condenser
C35	470 µµf., mica RCM20B471K condenser
C36	1000 µµf., mica RCM20B102K condenser
C37	1000 µµf., mica RCM20B102K condenser
C38	470 µµf., mica RCM20B471K condenser
C39	1000 µµf., mica RCM20B102K condenser
C40	470 µµf., mica RCM20B471K condenser
C41	1000 µµf., mica RCM20B102K condenser
C42	470 µµf., mica RCM20B471K condenser
C43	.1 µf., 400 v tubular, Astron MLL-4-1 condenser
C44	.01 µf., 500 v ceramic disc, Sprague #36C1-36C condenser
C45	.01 µf., 500 v ceramic disc, Sprague #36C1-36C condenser
C46	.01 µf., 500 v ceramic disc, Sprague #36C1-36C condenser
C47	.01 µf., 1000 v tubular, Mallory #OT-301 condenser

C48 470 μμf., ceramic, Erie Type GP2K condenser
C49 470 μμf., ceramic, Erie Type GP2K condenser
C50 470 μμf., ceramic, Erie Type GP2K condenser
C51 470 μμf., ceramic, Erie Type GP2K condenser
C52 .01 μf., 500 v ceramic disc, Sprague #36C1-36C condenser
C53 .01 μf., 500 v ceramic disc, Sprague #36C1-36C condenser
Type 1800 Wobbulator capacitor per TIC dwg. #1800B-00-1-A
F1 1 amp. fuse, Bussman #AGC-1
I1 #47 pilot light
L1 Inductance per TIC dwg. #1500-61-1-A
L2 Inductance per TIC dwg. #1500-61-1-A
L3 Inductance per TIC dwg. #1210-20-2-A
L4 Inductance per TIC dwg. #1210-20-2-A
PI binding-post, Hewlett Packard #10
P2 coaxial jack, UG-290/U, connector
P3 binding-post, Hewlett Packard #10
P4 binding-post, Hewlett Packard #10
S1 switch per TIC specification #S103A
S2 DPDT toggle, G.C. #1333, switch
S3 DPDT toggle, G.C. #1333, switch
S4 DPST toggle, G.C. #1332, switch
T1 power transformer, TIC #T-209
V1 Tube, 6X4
V2 Tube, 6AQ5
V3 Tube, 6AU6
V4 Neon bulb, NE-16-991
V5 Neon bulb, NE-51
V6 Tube, 12AU7
V7 Tube, 6J6
V8 Tube, 6AL5
V9 Tube, 6AL5
V10 Tube, 12AU7
V11 Tube, 6J6
V12 Tube, 6J6
V13 Tube, 6J6
V14 Tube, 6AL5
V15 Tube, 3TK2
Y1 thru Y10 Order special from TIC. Specify instrument type and frequency desired.

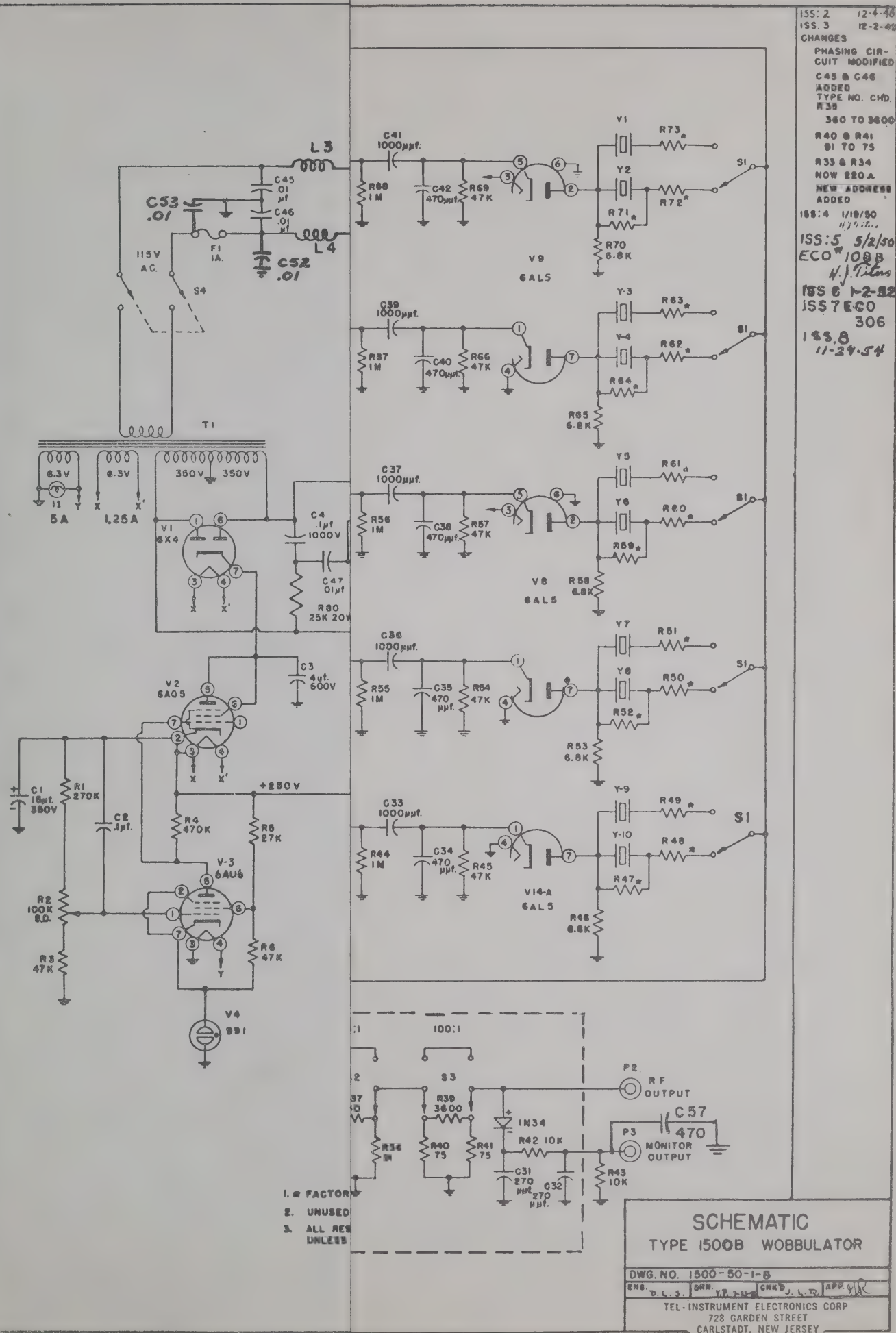
VOLTAGE TABLE

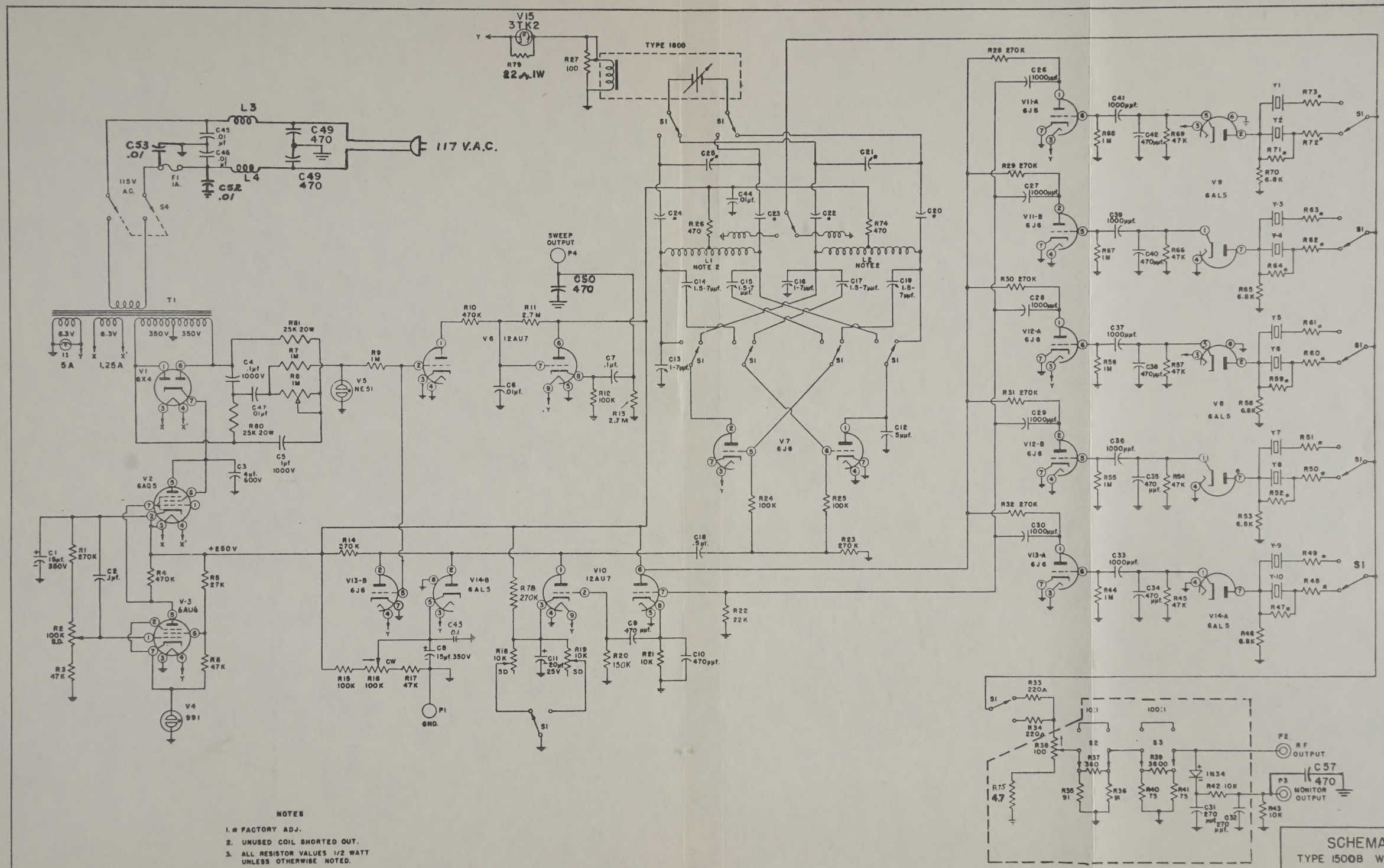
TUBE ELEMENT VOLTAGES MEASURED WITH RESPECT TO GROUND

TUBE PIN

Tube No.	Tube Type	1	2	3	4	5	6	7	8	9
V1	6X4	350 a-c	—	6.3 a-c	6.3 a-c	—	350 a-c	400	—	—
V2	6AQ5	212	250	6.3 a-c	6.3 a-c	395	395	—	—	—
V3	6AU6	50	56	*	6.3 a-c	216	183	56	—	—
V4	991/NE-16									
V5	NE-51									
V6	12AU7	40	–21	*	*	*	250	74	89	6.3 a-c
V7	6J6	250	250	6.3 a-c	6.3 a-c			*	—	—
V8	6AL5	1.5	0	*	6.3 a-c	1.5	*	0	—	—
V9	6AL5	1.5	0	*	6.3 a-c	1.5	*	0	—	—
V10	12AU7	35	0	4.5	*	*	250	0	15	6.3 a-c
V11	6J6	27	27	*	6.3 a-c	–1	–1	*	—	—
V12	6J6	35	35	*	6.3 a-c	–1	–1	*	—	—
V13	6J6	26	35	*	6.3 a-c	–1.5	–1	*	—	—
V14	6AL5	1	35	*	6.3 a-c	60	*	0	—	—
V15	3TK2	—	6.3 a-c	—	—	—	—	—	—	—

*Pin connected to ground. Line voltage 117 V a-c.


ISS: 2 12-4-48
ISS. 3 12-2-49
CHANGES
PHASING CIRCUIT MODIFIED
C45 & C46 ADDED
TYPE NO. CHD. R38 360 TO 3600
R40 & R41 91 TO 75
R33 & R34 NOW 220 A.
NEW ADDRESS ADDED
ISS: 4 1/19/50
ISS: 5 5/2/50
ECO 108B
ISS 6 1-2-52
ISS 7 ECO 306
ISS. 8 11-24-54
L3
L4
C45 .01 µf
C46 .01 µf
C53 .01
C52 .01
115 V A.C.
F1 1A.
S4
T1
6.3V
6.3V
350V 350V
5A
1.25A
V1 6X4
C4 .1µf 1000V
C47 01µf
R80 25K 20W
C3 4µf. 600V
V2 6A05
C1 18µf. 350V
R1 270K
C2 1µf.
R4 470K
R5 27K
+250V
V-3 6AU6
R2 100K P.O.
R3 47K
R6 47K
V4 991
C41 1000µµf.
R68 1M
C42 470µµf.
R69 47K
V9 6AL5
R73*
R72*
R71*
R70 6.8K
C39 1000µµf.
R67 1M
C40 470µµf.
R66 47K
R63*
R62*
R64*
R65 6.8K
C37 1000µµf.
R56 1M
C38 470µµf.
R57 47K
V8 6AL5
R61*
R60*
R59*
R58 6.8K
C36 1000µµf.
R55 1M
C35 470 µµf.
R54 47K
R52*
R50*
R53 6.8K
C33 1000µµf.
R44 1M
C34 470 µµf.
R45 47K
V14-A 6AL5
R49*
R48*
R47*
R46 6.8K
S1
Y1
Y2
Y3
Y4
Y5
Y6
Y7
Y8
Y9
Y10
1:1
100:1
S3
R39 3600
R40 75
R41 75
R42 10K
1N34
C31 270 µµf
C32 270 µµf
R43 10K
P2 RF OUTPUT
P3 MONITOR OUTPUT
C57 470
1. * FACTOR
2. UNUSED
3. ALL RES UNLESS
SCHEMATIC
TYPE 1500B WOBBULATOR
DWG. NO. 1500-50-1-8
ENG. D.L.J.
DRN. V.P. 2-14
CHK'D J.L.R.
APP.
TEL-INSTRUMENT ELECTRONICS CORP
728 GARDEN STREET
CARLSTADT, NEW JERSEY



NOTES

1. * FACTORY ADJ.
2. UNUSED COIL SHORTED OUT.
3. ALL RESISTOR VALUES 1/2 WATT UNLESS OTHERWISE NOTED.

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ECO# 1088
ISS 6 1-2-52
ISS 7 ECO 306
ISS.8 11-29-54

SCHEMATIC
TYPE 1500B WOBBULATOR

DWG. NO. 1500-50-1-B
ENG. D.L.J. DRN. M.P.H. CHK'D. J.L.B. APP'D.

TEL-INSTRUMENT ELECTRONICS CORP
728 GARDEN STREET
CARLSTADT, NEW JERSEY